

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018/2019

PPH 0135 – ELECTRICITY AND MAGNETISM (Foundation in Engineering)

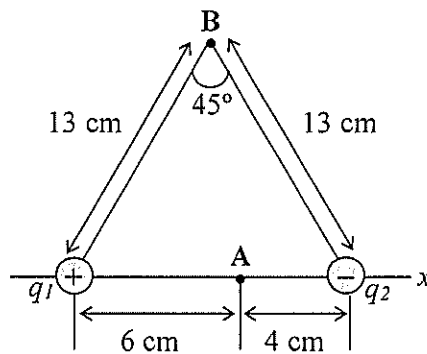
2 MARCH 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

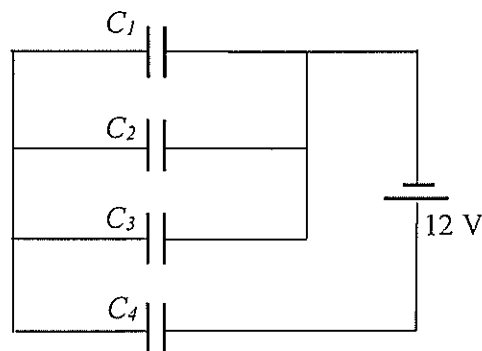
1. This question paper consists of **FIVE** pages excluding the cover page and the appendices with **FIVE (5)** questions only.
2. Attempt **ALL** questions. The distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. All necessary workings must be shown.

QUESTION 1 (10 marks)

- a) An electric dipole consists of two point charges, $q_1 = 12 \text{ nC}$ and $q_2 = -12 \text{ nC}$, placed 10 cm apart (**Figure Q1(a)**).
- i) Compute the potentials at point A and B. [2 marks]
- ii) If a charge, $q_3 = 12 \text{ nC}$ is placed at point B, find the magnitude and direction of the net force acting on it (q_3) [3 marks]

**Figure Q1(a)**

- b) **Figure Q1(b)** shows a combination of capacitors in a circuit. Each capacitor has a capacitance of $2.0 \mu\text{F}$.

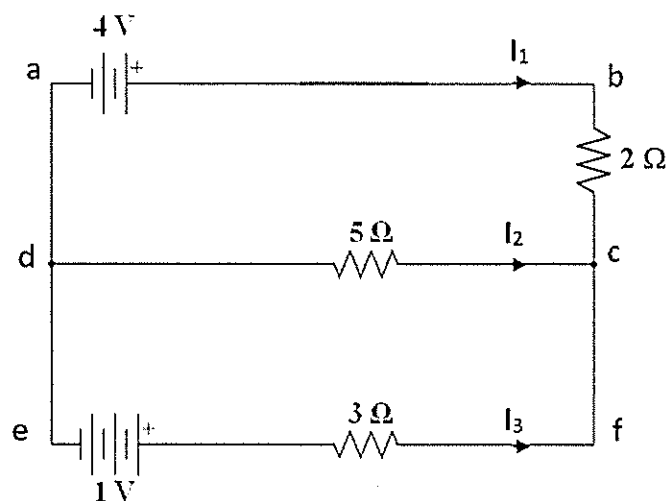
**Figure Q1(b)**

- i) Determine the equivalent capacitance of the circuit. [1.5 marks]
- ii) Calculate the amount of charge stored in C_3 . [2 marks]
- iii) Determine the voltage across C_2 . [1.5 marks]

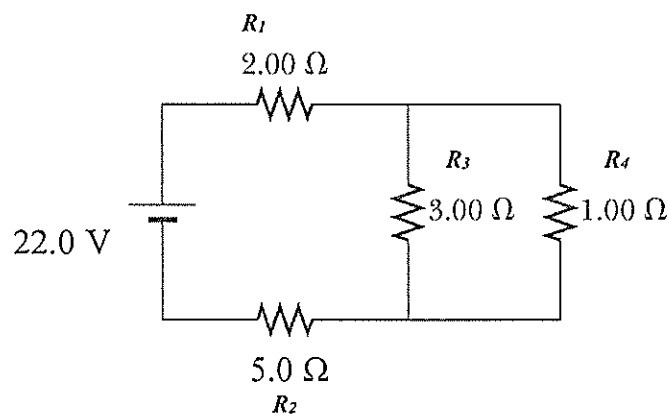
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QUESTION 2 (10 marks)

- a) A battery of $\xi = 2.50 \text{ V}$ has a terminal potential difference of 2.25 V when a resistor of 30.0Ω is connected to it. Calculate the internal resistance, r , of the battery. [2 marks]
- b) A DC circuit, consists of two batteries is configured as shown in **Figure Q2(a)**.
- Write the equation of Kirchhoff's current law applied at point **c**. [0.5 marks]
 - Write the equation of Kirchhoff's voltage law for loop **abcd** and loop **cdefc**. [2 marks]
 - Based on parts (i) and (ii), determine I_1 and I_2 . [2.5 marks]

**Figure Q2(a)**

- c) Find the equivalent Thevenin's resistance (R_{TH}) and the equivalent Thevenin's Voltage (V_{TH}) across resistor R_4 for the circuit shown in **Figure Q2(b)** below.

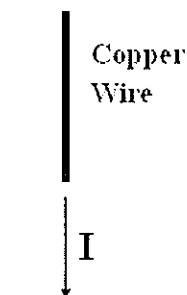


[3 marks]

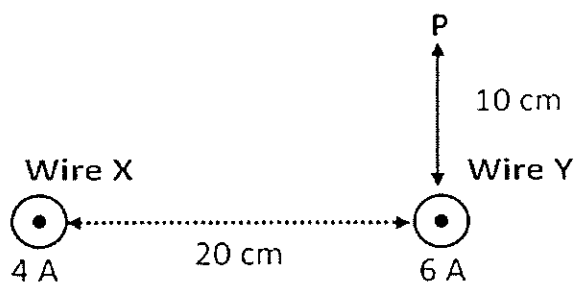
Figure Q2(b)**Continued ...**

QUESTION 3 (10 marks)

- a) **Figure Q3(a)** shows a copper wire carrying a current of I in free space. Redraw **Figure Q3(a)** and sketch the magnetic field produced by the copper wire. [1 mark]

**Figure Q3(a)**

- b) Two wires, X and Y, are carrying currents of 4A and 6A, respectively, as shown in **Figure Q3(b)**.
- Draw the directions of the magnetic field at point P. [1 mark]
 - Calculate the magnitude of the magnetic field at point P due to the currents in wire X and wire Y. [2 marks]
 - Determine the net magnitude and direction of the magnetic field at point P. [3 marks]

**Figure Q3(b)**

- c) Two solenoids A and B, which are placed close to each other, have 300 and 600 turns, respectively. A current of 1.5A flows through coil A, produces magnetic flux of 1.2×10^{-4} Weber through each turn of A and a flux of 0.9×10^{-4} Weber through each turn of B.
- Determine mutual inductance of A and B. [1.5 marks]
 - Find the average e.m.f. induced in coil B when the current in coil A is stopped in 0.2s. [1.5 marks]

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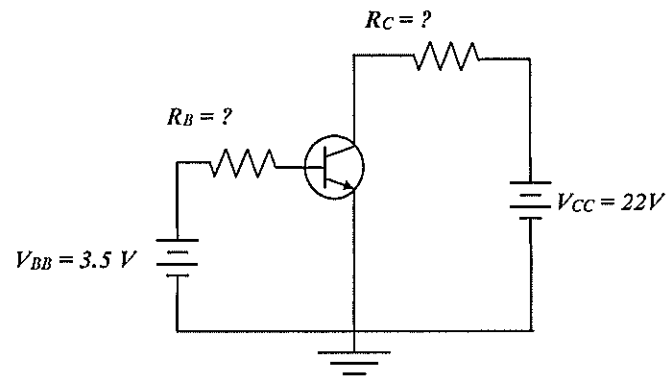
QUESTION 4 (10 marks)

- a) In a certain series RLC circuit operating at the frequency of 40.0 Hz, the rms current is 4.0A, the rms voltage is 240V, and the current leads the voltage by 50° .
- i) Find the impedance, Z of the RLC network, hence determine the resistance, R of the circuit at 40 Hz. [2 marks]
 - ii) Calculate the **reactive** power and the **apparent** power of the circuit at 40 Hz. [2 marks]
- b) A series *RLC* circuit containing a 50 Hz power source with $V_{\text{rms}} = 300 \text{ V}$, a resistor, $R = 200 \Omega$, an inductor, $L = 500 \text{ mH}$, and a capacitor, $C = 10 \mu\text{F}$.
- i) Determine the value of the peak voltage of the source. [1 mark]
 - ii) Calculate the impedance of the circuit. [3 marks]
 - iii) If the frequency of the power source is changed to resonance frequency of the circuit, find maximum current flowing in the circuit. [1 mark]
 - iv) Determine the resonance frequency of the circuit. [1 mark]

Continued ...

QUESTION 5 (10 marks)

- a) What is meant by doping in semiconductors? [1 mark]
- b) There are two types of Bipolar Junction Transistor (BJT).
- i) Name the two types of BJT. [1 mark]
- ii) Draw the electronic symbol of each transistor in part (i). Label all terminals in each symbol. [2 marks]
- c) **Figure Q5** shows a germanium transistor circuit with two unknown resistors, the base terminal resistor R_B and the collector terminal resistor R_C . If the collector current, $I_C = 7.0 \text{ mA}$, $\alpha_{dc} = 0.6$, $\beta_{dc} = 42$, and $V_{CE} = 8.5 \text{ V}$, find the values of R_B and R_C .

**Figure Q5**

[6 marks]

End of Paper

APPENDIX 1

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	$9.11 \times 10^{-31} \text{ kg}$
Proton mass,	m_p	$1.67 \times 10^{-27} \text{ kg}$
Elementary charge	e	$1.602 \times 10^{-19} \text{ C}$
Gravitational constant	G	$6.67 \times 10^{-11} \text{ N.m}^2/\text{kg}^2$
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	$1.38 \times 10^{-23} \text{ J/K}$
Compton wavelength	λ_c	$2.426 \times 10^{-12} \text{ m}$
Planck's constant	h	$6.626 \times 10^{-34} \text{ J.s}$
Speed of light in vacuum	c	$3.0 \times 10^8 \text{ m/s}$
Rydberg constant	R_H	$1.097 \times 10^7 \text{ m}^{-1}$
Acceleration due to gravity,	g	9.81 m/s^2
Atomic mass unit (1u)	u	$1.66 \times 10^{-27} \text{ kg}$
Avogadro's number	N_A	$6.023 \times 10^{23} \text{ mol}^{-1}$
Threshold of intensity of hearing	I_o	$1.0 \times 10^{-12} \text{ W/m}^2$
Coulomb constant	k	$8.988 \times 10^9 \text{ N.m}^2/\text{C}^2$
Permittivity of free space	ϵ_o/κ_o	$8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2$
Permeability of free space	μ_o	$4\pi \times 10^{-7} \text{ H/m}$

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

APPENDIX II

List of formulas

$$A_v = \frac{V_c}{V_b}$$

$$\alpha_{dc} = \frac{\beta_{dc}}{\beta_{dc} + 1}$$

$$\beta_{dc} = \frac{\alpha_{dc}}{1 - \alpha_{dc}}$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 n I$$

$$\xi = V + Ir$$

$$\xi = b l v$$

$$\xi = -N \frac{\Delta \Phi}{\Delta t}$$

$$\xi = -L \frac{dI}{dt}$$

$$\xi = -M \frac{dI}{dt}$$

$$F = BIL \sin \theta$$

$$F = qvB \sin \theta$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$I_{tot} = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$I = neA(v_n + v_p)$$

$$I = nev_d A$$

$$I = I_{max} \sin \omega t$$

$$I_{rms} = \frac{I_{max}}{\sqrt{2}}$$

$$I_x = \left(\frac{R_T}{R_x} \right) I_T$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_0 N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$P_t = I_{rms} V_{rms} \cos \phi$$

$$P_r = V_{rms} I_{rms} \sin \phi$$

$$P_a = I_{rms}^2 Z$$

$$R = \frac{\rho L}{A}$$

$$R = R_0 [1 + \alpha(T - T_0)]$$

$$R_T = R_1 + R_2 + R_3 + \dots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

$$r = \frac{mv}{Bq}$$

$$\tau = NBIA \sin \theta$$

$$U = \frac{1}{2} LI^2$$

$$U = \frac{1}{2} B^2 A \frac{l}{\mu_0}$$

$$V_H = Bvd$$

$$V = V_{max} \sin \omega t$$

$$V_{rms} = \frac{V_{max}}{\sqrt{2}}$$

$$V_x = \left(\frac{R_x}{R_T} \right) V_s$$

$$X_C = \frac{1}{2\pi f C}$$

$$X_L = 2\pi f L$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\oint B \cdot dl = \mu_0 I$$

$$d\mathbf{B} = \frac{\mu_0 I}{4\pi} \frac{d\ell \times \hat{r}}{r^2}$$

$$\Phi_B = BA \cos \theta$$

$$\cos \phi = \frac{R}{Z}$$

$$\tan \phi = \frac{X_L - X_C}{R}$$